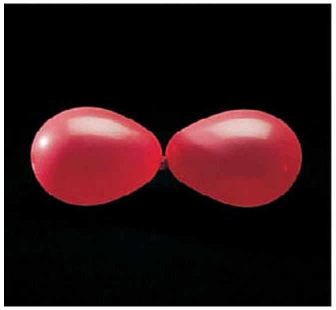
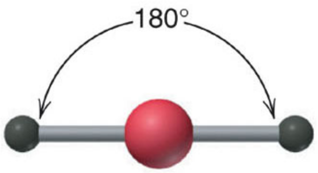
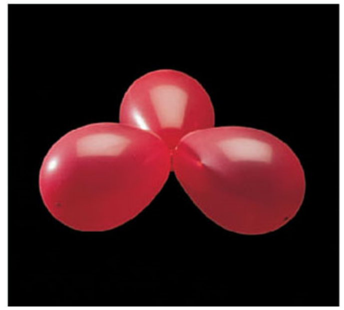
Electron-Group Geometry

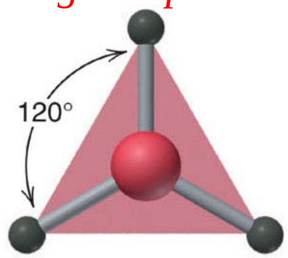


linear

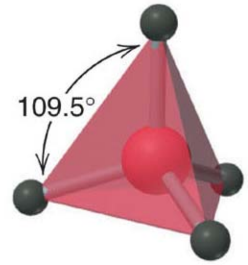




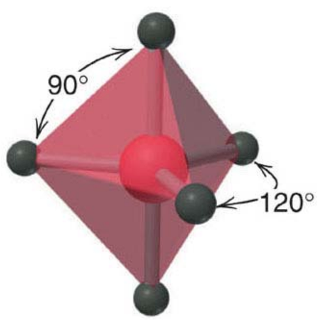
trigonal planar



tetrahedral



trigonal bipyramidal



octahedral

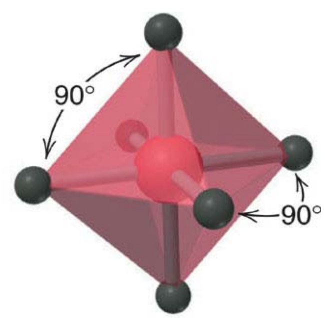


TABLE 9.2 ■ Electron-Domain Geometries and Molecular Shapes for Molecules with Two, Three, and Four Electron Domains around the Central Atom

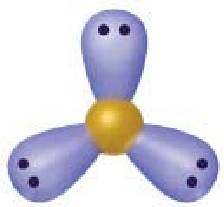
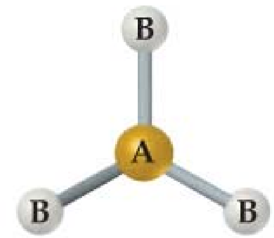
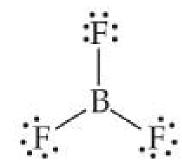
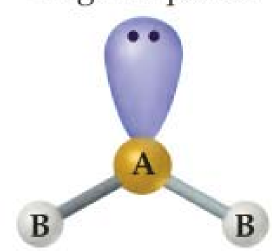
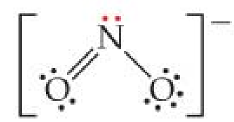
Number of Electron Domains	Electron-Domain Geometry	Bonding Domains	Nonbonding Domains	Molecular Geometry	Example
2	 Linear	2	0	 Linear	
3	 Trigonal planar	3	0	 Trigonal planar	
		2	1	 Bent	

TABLE 9.2 ■ Electron-Domain Geometries and Molecular Shapes for Molecules with Two, Three, and Four Electron Domains around the Central Atom

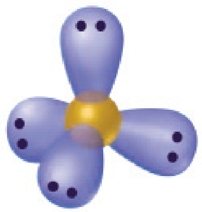
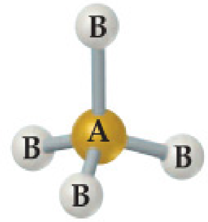
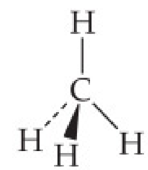
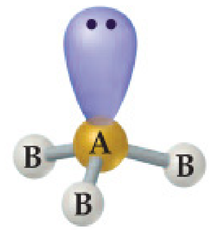
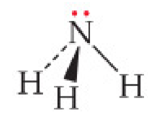
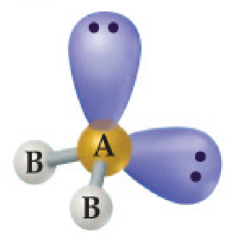
Number of Electron Domains	Electron-Domain Geometry	Bonding Domains	Nonbonding Domains	Molecular Geometry	Example
4	 Tetrahedral	4	0	 Tetrahedral	
		3	1	 Trigonal pyramidal	
		2	2	 Bent	

TABLE 9.3 ■ Electron-Domain Geometries and Molecular Shapes for Molecules with Five and Six Electron Domains around the Central Atom

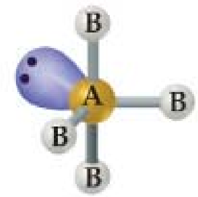
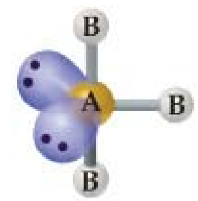
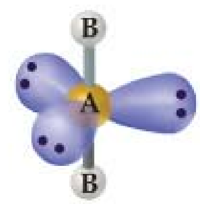
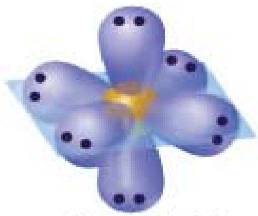
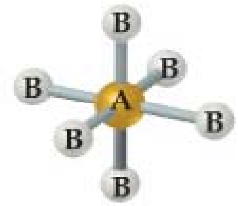
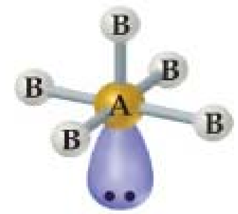
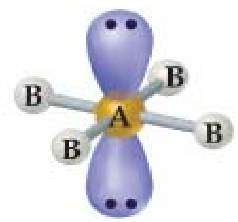
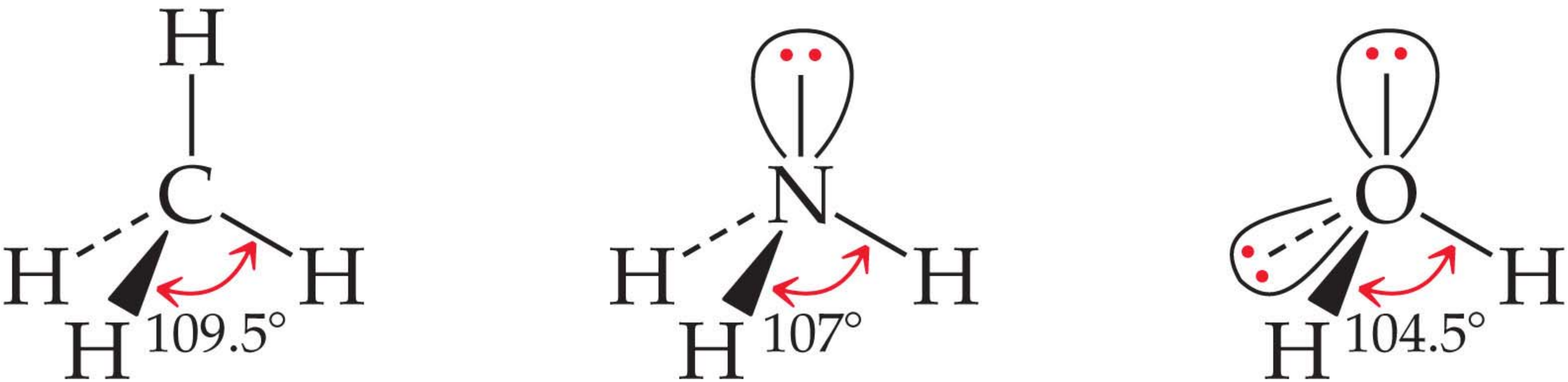
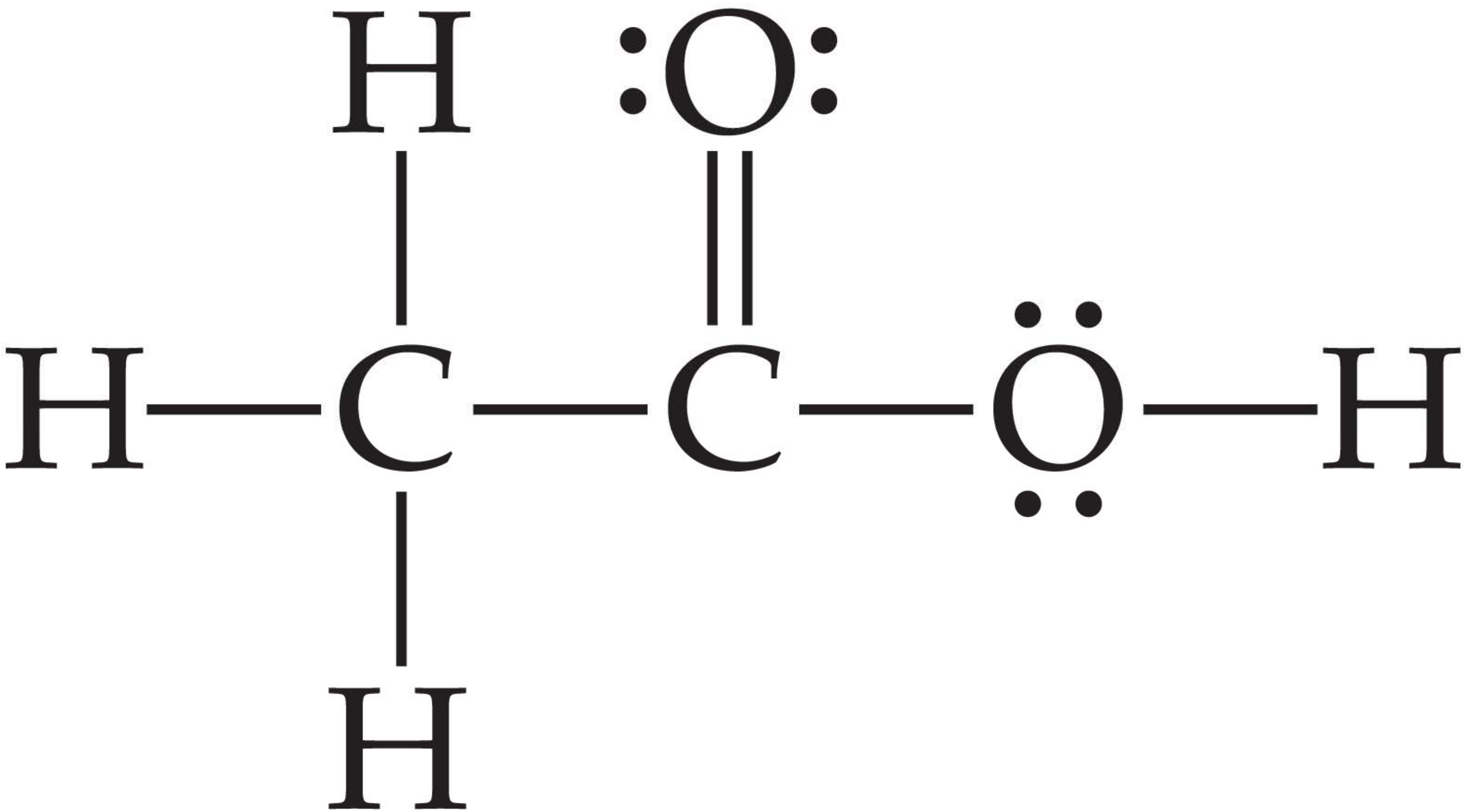
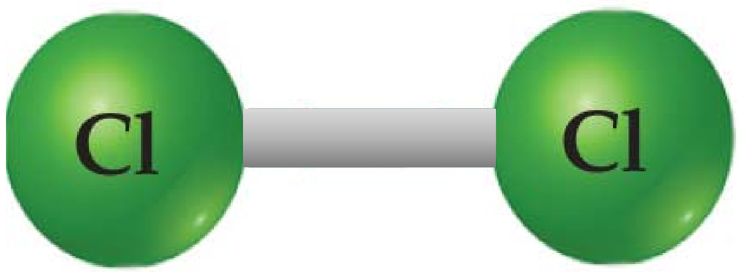
Total Electron Domains	Electron-Domain Geometry	Bonding Domains	Nonbonding Domains	Molecular Geometry	Example
5	 Trigonal bipyramidal	5	0	 Trigonal bipyramidal	PCl_5
		4	1	 Seesaw	SF_4
		3	2	 T-shaped	ClF_3
		2	3	 Linear	XeF_2

TABLE 9.3 ■ Electron-Domain Geometries and Molecular Shapes for Molecules with Five and Six Electron Domains around the Central Atom

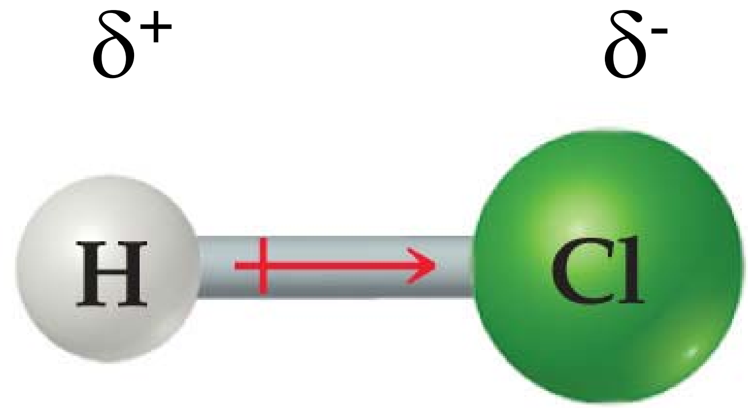
Total Electron Domains	Electron-Domain Geometry	Bonding Domains	Nonbonding Domains	Molecular Geometry	Example
6	 Octahedral	6	0	 Octahedral	SF_6
		5	1	 Square pyramidal	BrF_5
		4	2	 Square planar	XeF_4


109.5°
107°
104.5°

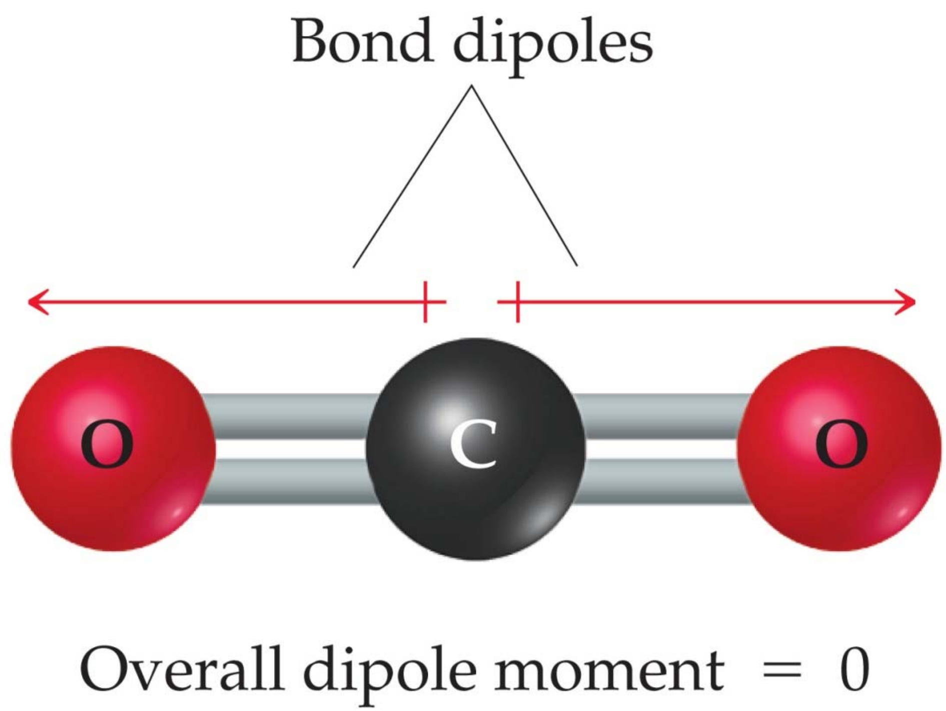


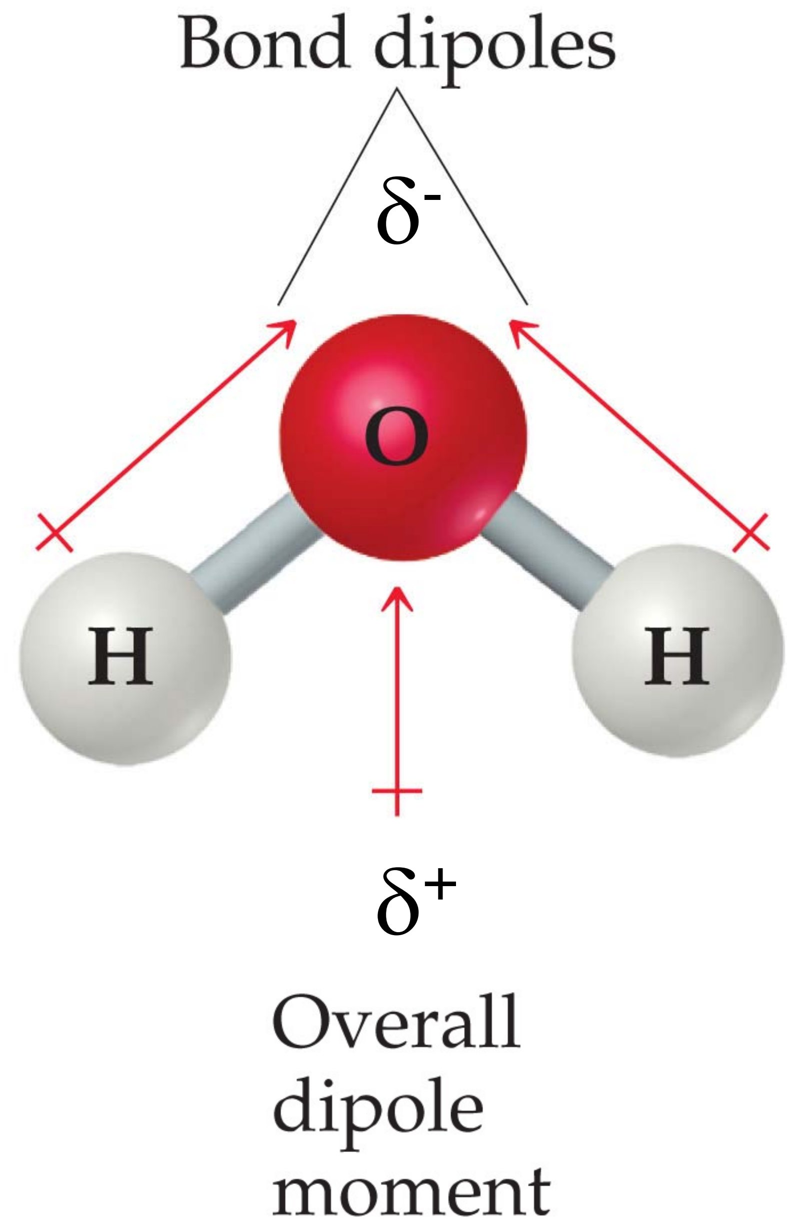


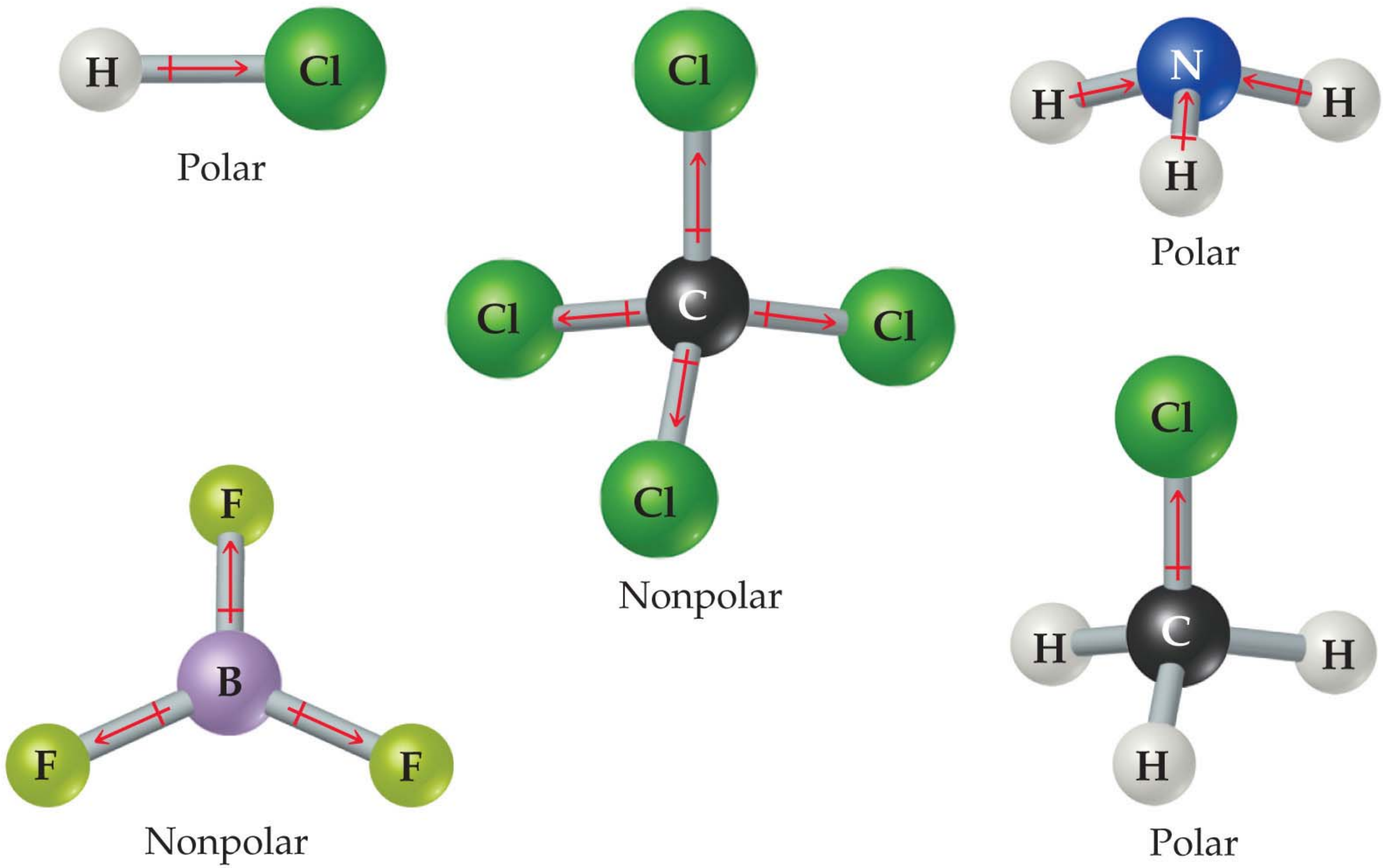
Nonpolar



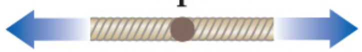
Polar


Bond dipoles
O
C
O
Overall dipole moment = 0


Bond dipoles
δ-
O
H
H
δ+
Overall
dipole
moment


H
Cl
Polar
Cl
Cl
C
Cl
Cl
Nonpolar
H
N
H
H
Polar
F
B
F
F
Nonpolar
Cl
H
C
H
H
Polar

Nonpolar

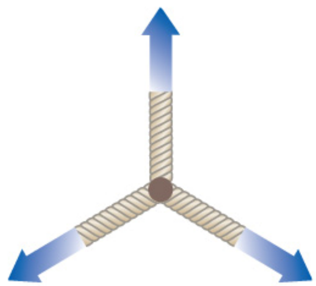


Two identical polar bonds pointing in opposite directions will cancel. The molecule is nonpolar.

Polar

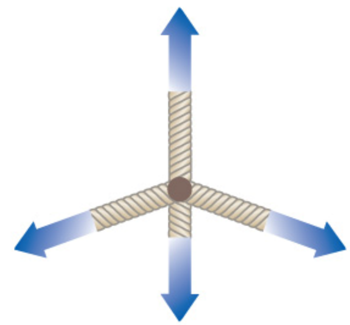
Two polar bonds with an angle of less than 180° between them will not cancel. The molecule is polar.

Nonpolar



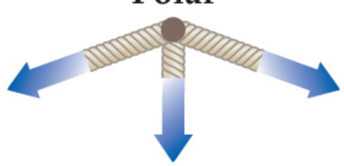
Three identical polar bonds at 120° from each other will cancel. The molecule is nonpolar.

Nonpolar



Four identical polar bonds in a tetrahedral arrangement (109.5° from each other) will cancel. The molecule is nonpolar.

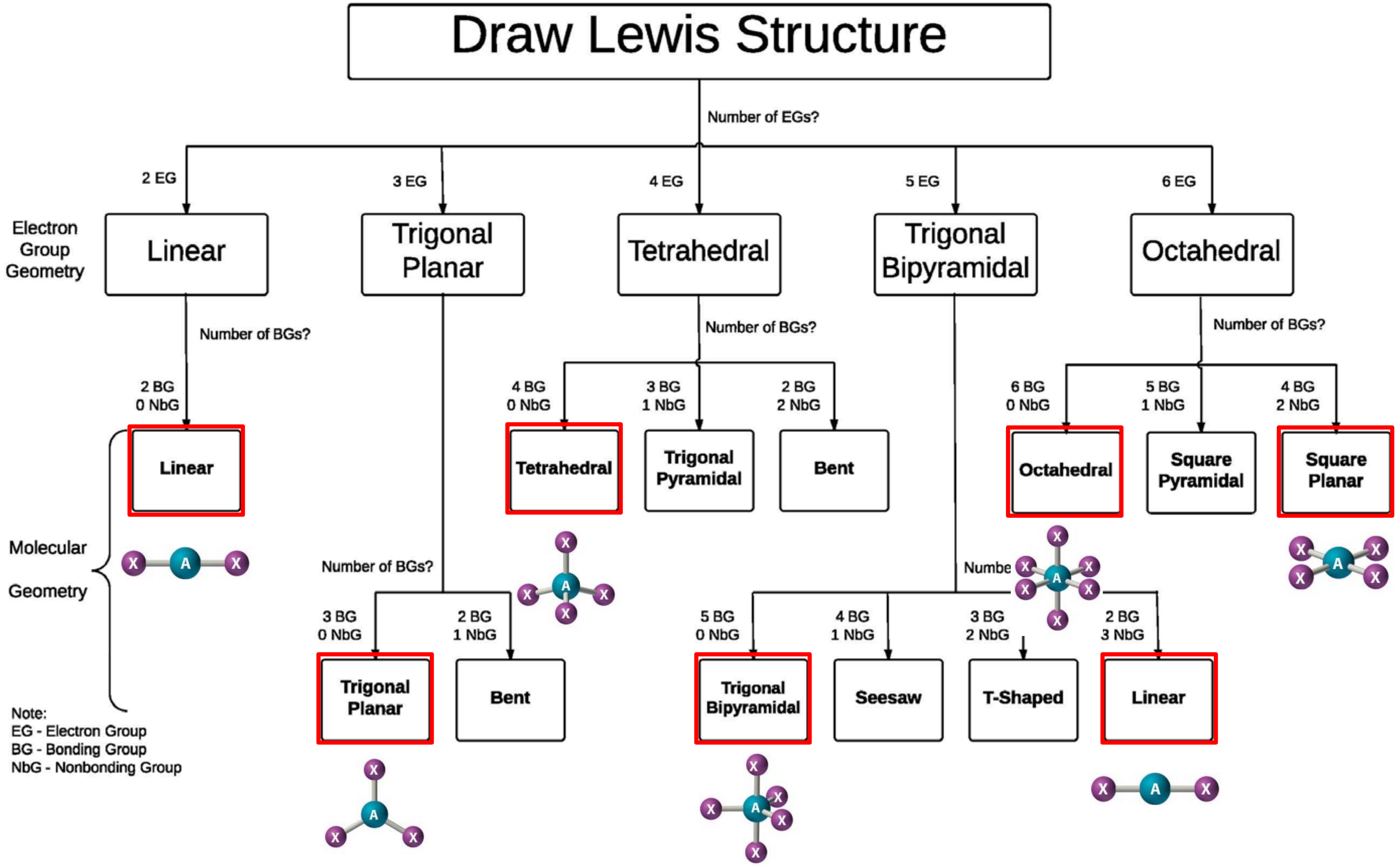
Polar



Three polar bonds in a trigonal pyramidal arrangement (109.5°) will not cancel. The molecule is polar.

> *Note: In all cases where the polar bonds cancel, the bonds are assumed to be identical. If one or more of the bonds are different than the other(s), the bonds will not cancel and the molecule is polar.*

Molecular Shapes that Result in Nonpolar Molecules if Bonds are Identical



Vector Addition

From **Chemistry: A Molecular Approach** by Nivaldo Tro

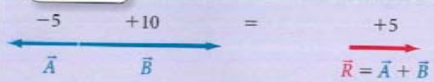
As discussed previously, we can determine whether a molecule is polar by summing the vectors associated with the dipole moments of all the polar bonds in the molecule. If the vectors sum to zero, the molecule will be nonpolar. If they sum to a net vector, the molecule will be polar. In this box, we show how to add vectors together in one dimension and in two or more dimensions.

One Dimension

To add two vectors that lie on the same line, assign one direction as positive. Vectors pointing in that direction have positive magnitudes. Consider vectors pointing in the opposite direction to have negative magnitudes. Then sum the vectors (always remembering to include their signs), as shown in the following examples.

Example 1

Example 2

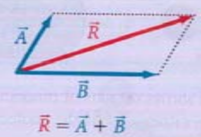


Example 3

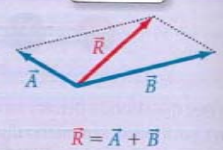
Two or More Dimensions

To add two vectors, draw a parallelogram in which the two vectors form two adjacent sides. Draw the other two sides of the parallelogram parallel to and the same length as the two original vectors. Draw the resultant vector beginning at the origin and extending to the far corner of the parallelogram.

Example 4

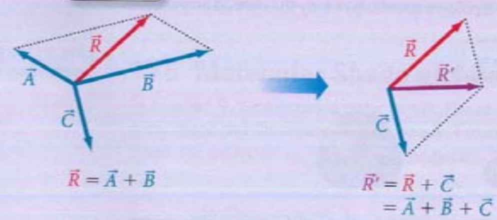


Example 5



To add three or more vectors, add two of them together first, and then add the third vector to the result.

Example 6



Example 7